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HOST-PLANT UTILIZATION BY *PIERIS NAPI* POPULATIONS IN CALIFORNIA (LEPIDOPTERA: PIERIDAE)

By Arthur M. Shapiro[1]

Department of Zoology, University of California, Davis, Calif. 95616

Oligophagous or polyphagous insects frequently exhibit ecologically or geographically complex patterns of host-plant utilization. Such patterns have recently been documented for the butterflies *Colias alexandra* Edwards (Pieridae) (Ellis, 1974) and *Euphydryas editha* Boisduval (Nymphalidae) (White and Singer, 1974). This paper reports a similar situation among California populations of the Gray-Veined White, *Pieris napi* Linnaeus (Pieridae) and notes its potential significance in interspecific competition.

Pieris napi is a circumpolar species; in its extensive boreal and temperate range it has been recorded on a great variety of plants of the family Cruciferae. In California it is widely distributed in foothill and lower montane (Yellow Pine-Incense Cedar-Douglas Fir) environments in the Coast Ranges south to San Luis Obispo County and in the Sierra Nevada at least as far south as Yosemite, but its host preferences have been very poorly documented. In their survey of Yosemite butterflies, Garth and Tilden (1963) listed in an Appendix "some plants on which Yosemite butterflies feed as larvae." Unfortunately these records, which are mostly not attributed, do not appear to be limited to Yosemite populations. Garth and Tilden list four Crucifer genera as hosts of *P. napi: Barbarea* (winter cress, yellow rocket), *Brassica* (mustard), *Raphanus* (radish), and *Dentaria* (milkmaids, crinkleroot, toothwort). Of these, all but *Raphanus* are known hosts of *P. napi* in the northeastern United States. Tilden (1965) recorded *P. napi* in the "San Francisco Bay area" on *Dentaria* only.

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Figure 1. Locations of California *Pieris napi* populations.

During 1974 a number of Sierran and Coast Range populations of *P. napi* were sampled for photoperiodism studies, resulting in the incidental accumulation of data on host selection. The locations of these populations are shown in figure 1. The pattern of host selection proved to be of considerable interest, as reported below.

San Andreas Reservoir, San Mateo County. — This is a coastal, facultatively bivoltine population from a gully (elevation about 200 feet) subject to summer fog. On 10 April 1974, 58 ova of *P. napi* were found by searching 86 plants of *Barbarea verna* (Mill.) Asch., and three females were observed ovipositing on this plant. No ova were found on 25 plants of *Dentaria californica* Nutt. growing nearby in the same canyon. Ova on *B. verna* were placed on leaves (mostly on lower surfaces), stems, and pedicels. Most of the *Barbarea* plants had only cauline leaves and were in the early stages of flowering. *Dentaria* were in the advanced stages of flowering and had some green siliques.

Mix and Gates Canyons, Solano County. — This is a strictly univoltine population from summer-arid canyons of the east slope of the Vaca Mountains, central Inner Coast Ranges, open to the Sacramento Valley (elevations 500 to 2000 feet). On 4 April 1974, 39 ova of *P. napi* and 21 of *Anthocaris sara* Reakirt were found on 66 plants of *Barbarea verna;* the *sara* ova were mostly in the inflorescence and on the upper surfaces of leaves, while the *napi* ova were scattered as described for San Mateo County, but seldom on the upper surfaces of leaves. No Pierid ova of any kind were found on 40 *Dentaria californica* near the *Barbarea.* On 19 May 1974, 14 larvae of *P. napi* were collected on *B. verna.* They were feeding on leaves, and the green siliques had not been damaged although most of the plants were nearly or quite defoliated; only one *napi* larva was found feeding on siliques, and this was on a plant whose leaves and petioles had been entirely consumed. Seven larvae of *A. sara* were found on five plants of *Sisymbrium officinale* (L.) Scop. (hedge mustard) and two on *B. verna.* All of these were feeding on green siliques only, on plants whose leaves were undamaged. Four of 20 *Dentaria* examined had been defoliated, apparently by Pierid larvae, but no larvae were collected.

Near Washington, Nevada County. — Located in the South Yuba River canyon at about 2600 feet on the west slope of the Sierra, this is also a univoltine population. On 3 May 1974, 78 ova of *P. napi* were collected by the author and S. R. Sims from about two dozen immature *Arabis glabra* (L.) Bernh. (tower mustard). The ova

had been laid on both upper and lower surfaces of rosette leaves, lower surfaces of the (appressed) cauline leaves (often near the point of attachment, as was also true on *Barbarea verna*), and on stems. One larva (3rd instar) was found, and two ovipositing females were observed. On 22 May, 16 additional ova and 5 larvae were found at the same spot on the same plants, which were now mature and beginning to set fruit. Abundant evidence of larval feeding was found on the rosettes and lower cauline leaves, but the flowers and siliques were undamaged. Fourteen plants of flowering *Barbarea orthoceras* Ledeb. were found in a grassy meadow 0.7 mile up the canyon, within the area where adult *P. napi* had been seen, but no ova, larvae, or feeding damage could be located on them.

Lang Crossing, Nevada County. — This population is at about 4500 feet in the South Yuba River canyon, at or near the upper altidudinal limit of Sierran *P. napi;* it is also univoltine. On 22 May 1974, 3 ova of *P. napi* were found in a stand of 30 immature *Arabis glabra* and none on 20 flowering *Barbarea orthoceras* growing immediately adjacent to them. On 2 June the same stand was again searched, producing 11 ova of *P. napi,* 20 of *P. rapae* Linnaeus, 3 of *A. sara* and 2 of *Anthocaris lanceolata* Lucas from *A. glabra,* and 8 of *A. sara* from *B. orthoceras.* An additional 34 ova of *P. napi* were collected from *A. glabra* elsewhere in the vicinity. Four larvae of *P. napi* were found feeding on rosette leaves of *A. glabra,* and two of *A. sara* on inflorescences and siliques of *B. orthoceras.* On 26 June four mature *A. sara* and two immature *A. lanceolata* larvae were found on siliques of *A. glabra* and one mature *A. sara* larva on siliques of *B. orthoceras.* Many *A. glabra* plants showed feeding damage to the rosettes, but only seven *P. rapae* larvae were found; probably most *napi* had already pupated. *Pieris rapae,* which is multivoltine, was flying in abundance at Lang Crossing on 19 July.

Despite the large number of Pierid species and individuals, the visible impact of feeding on the Crucifers at Lang Crossing was quite small. In particular, *Arabis glabra* plants often produced several hundred siliques on leafy, two- to four-foot stems.

Discussion

There are ten species of obligate Crucifer-feeding Pierids in California, occurring in various combinations at different localities. Some of these are spring-univoltine, a few are spring-bivoltine, and some are multivoltine. How they partition the available Crucifers among themselves may shed valuable light on the broad problems

of niche differentiation, competitive exclusion, and species packing. Emmel (1974) reported three species of inflorescence feeders (*Pieris protodice* Boisduval and LeConte, *A. sara* and *A. lanceolata*) on *Arabis glabra* in Riverside County, 2 June 1973. Shapiro (1974) described five- and six-species Pierid assemblages in two high Sierran localities and concluded that competition is reduced by behavioral mechanisms (habitat selection).

Pieris napi occurs with up to six other Crucifer-feeding Pierids at the four localities described above. Based on adult collections, the Crucifer-feeding Pierid faunas of the four localities are (inflorescence feeders are marked "I"; others primarily leaf feeders):

San Andreas Reservoir: *P. napi, P. rapae, A. sara* (I), *Euchloe ausonides* Lucas (I).

Mix and Gates Canyons: *P. napi, P. rapae, P. sisymbrii* Boisduval (I?), *A. sara* (I), *E. ausonides* (I).

Washington: *P. napi, P. rapae, A. sara* (I), *A. lanceolata* (I), *E. ausonides* (I).

Lang Crossing: *P. napi, P. rapae, P. sisymbrii* (I?), *A. sara* (I), *A. lanceolata* (I), *E. ausonides* (I), *E. hyantis* Edwards (I).

Not all of these breed in the same microhabitats. At Lang Crossing, for example, *P. sisymbrii* and *E. hyantis* are found only in exposed rocky situations and appear to breed only on *Streptanthus,* and are thus not in competition with the woodland species. In examining the fauna of particular plants in particular habitats, the division of Pierids into a leaf-feeding and an inflorescence/silique feeding guild seems paramount. At Mix and Gates Canyons, where *Barbarea* is obviously in "short supply" and frequently completely defoliated, at least one species from each guild (*P. napi, A. sara*) can occur on this plant. At Lang Crossing the combined visible impact of four species — two of each guild — on *Arabis glabra* is so small that it is tempting to speculate that the populations are regulated by other factors below the level at which interspecific competition would be significant.

Despite the potential for interspecific competition, at each of the study areas one plant received the bulk of the attention from Pierids while another appeared largely or wholly unutilized. It remains to be seen whether this reflects nutritional or toxicological unsuitability of certain Crucifer species. (In unpublished laboratory studies, Shapiro and F. Slansky (*pers. comm.*) have found variation in the suitability of native and weedy Crucifers as hosts of *Pieris rapae*

and other species.) It is also possible that host selection by ovipositing females is closely tied to host plant phenology, and that flowering condition of the plants, and possible correlated changes in mustard oil concentrations, may determine the patterns observed.

References

Ellis, S. L.
1974. Field observations on *Colias alexandra* Edwards (Pieridae). J. Lepid. Soc. **28**: 114-125.

Emmel, J. F.
1974. *in* R. L. Langston. Zone 1. Season Summary, Lepid. Soc. News, 25 June, p. 3.

Garth, J. S. and J. W. Tilden
1963. Yosemite Butterflies. J. Res. Lepid. 2: 1-96.

Shapiro, A. M.
1974. Ecological and behavioral aspects of coexistence in six Crucifer-feeding Pierid butterflies in the central Sierra Nevada. Amer. Midl. Naturalist, in press.

Tilden, J. W.
1965. *Butterflies of the San Francisco Bay Region.* Berkeley and Los Angeles: University of California Press. 88 pp.

White, R. R. and M. C. Singer
1974. Geographical distribution of host plant choice in *Euphydryas editha* (Nymphalidae). J. Lepid. Soc. **28**: 103-106.